

WHAT IS CLAIMED IS:

1. A method of using a feedback control to non-invasively identify and locate one or more subsurface targets based on predetermined conditions for selective laser treatment at a tissue surface area, comprising the steps of:

 directing one of a polarized and an unpolarized light having a predetermined wavelength at the tissue surface area;

 detecting one or more reflections of said light using a multi-dimensional photo-sensor;

 determining a location and one or more characteristics for each of the one or more subsurface targets based upon the one or more reflections detected by said photo-sensor and said predetermined conditions, said predetermined conditions defined at least in part by one of predetermined image analysis and mathematical algorithms; and

 selectively treating the one or more subsurface targets using a laser of a predetermined wavelength and a predetermined power in accordance with the determined location and the one or more determined characteristics.

2. The method of claim 1, wherein the one or more determined characteristics include at least one of a size, a shape, a color, a contrast, a brightness, a pattern, a structure, and a treatment status of tissue at the one or more subsurface targets.

3. The method of claim 1, wherein the one or more determined characteristics include at least one of photometric, spectrometric, and topological properties of tissue at the one or more subsurface targets.

4. The method of claim 1, further comprising the step of pulsing the laser on and off to control laser delivery to the one or more subsurface targets.

5. The method of claim 1, further comprising the step of adjusting one or more parameters of the laser in accordance with the one or more determined characteristics.

6. The method of claim 5, wherein the one or more parameters include at least one of a spot size, a pulse width, a wavelength and a power of the laser.

7. The method of claim 6, wherein the spot size is adjusted through actuated movement of one or more optical components.

8. The method of claim 7, wherein the one or more optical components includes one or more focusing lenses.

9. The method of claim 1, wherein the directing, detecting, and determining steps provide rapid feedback for tracking rapid relative movement between the laser and the one or more subsurface targets so that laser-targeting error is minimized.

10. The method of claim 9, wherein the rapid feedback has a bandwidth of more than 0.5 Hz.

11. The method of claim 1, further comprising the step of performing real time diagnosis of treatment result and efficacy of the heating step by repeating the directing, detecting, and determining steps after the heating step.

12. The method of claim 1, wherein the feedback control is one of semi-automatic and automatic.

13. The method of claim 1, wherein a spot size of the laser is less than 3 mm.

14. The method of claim 1, wherein the laser is a continuous wave laser.

15. The method of claim 1, wherein the determined location determined at the determining step for said each subsurface target is determined by inference from a corresponding location detected at said detecting step.

16. The method of claim 15, wherein said inference is based on the predetermined conditions.

17. The method of claim 1, wherein said feedback control is one of a closed-loop feedback control and a quasi-closed-loop feedback control.

18. The method of claim 1, further comprising the step of determining a polarization of the one or more reflections, wherein the location and one or more characteristics for each of the one or more subsurface targets are determined based upon the determined polarization.

19. The method of claim 1, wherein said treating includes one of heating and modifying the one or more subsurface targets.

20. An apparatus, having a feedback control, for non-invasively identifying and locating one or more subsurface targets based on predetermined conditions for selective laser treatment at a tissue surface area, said apparatus comprising:

means for directing one of a polarized and an unpolarized light having a predetermined wavelength at the tissue surface area;

means for detecting one or more reflections of said light using a multi-dimensional photo-sensor;

means for determining a location and one or more characteristics for each of the one or more subsurface targets based upon the one or more reflections detected by said photo-sensor and said predetermined conditions, said predetermined conditions defined at least in part by one of predetermined image analysis and mathematical algorithms; and

means for selectively treating the one or more subsurface targets using a laser of a predetermined wavelength and a predetermined power in accordance with the determined location and the one or more determined characteristics.

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✓21. The apparatus of claim 20, wherein the one or more determined characteristics include at least one of a size, a shape, a color, a contrast, a brightness, a pattern, a structure, and a treatment status of tissue at the one or more subsurface targets.

✓22. The apparatus of claim 20, wherein the one or more determined characteristics include at least one of photometric, spectrometric, and topological properties of tissue at the one or more subsurface targets.

✓23. The apparatus of claim 20, wherein the treating means pulses the laser on and off to control laser delivery to the one or more subsurface targets.

✓24. The apparatus of claim 20, wherein the treating means adjusts one or more parameters of the laser in accordance with the one or more determined characteristics.

✓25. The apparatus of claim 24, wherein the one or more parameters include at least one of a spot size, a pulse width, a wavelength and a power of the laser.

✓26. The apparatus of claim 25, wherein the spot size is adjusted through actuated movement of one or more optical components.

✓27. The apparatus of claim 26, wherein the one or more optical components includes one or more focusing lenses.

✓28. The apparatus of claim 20, wherein the directing, detecting, and determining means perform rapid feedback for tracking rapid relative movement between the laser and the one or more subsurface targets so that laser-targeting error is minimized.

⑤ 29. The apparatus of claim 28, wherein the rapid feedback has a bandwidth of more than 0.5 Hz.

30. The apparatus of claim 20, wherein the directing, detecting, and determining means perform real time diagnosis of treatment result and efficacy of the heating means.

31. The apparatus of claim 20, wherein the feedback control is one of semi-automatic and automatic.

32. The apparatus of claim 20, wherein a spot size of the laser is less than 3 mm.

33. The apparatus of claim 20, wherein the laser is a continuous wave laser.

34. The apparatus of claim 20, wherein the determining means determines the location for said each subsurface target by inference from a corresponding location detected by said detecting means.

35. The apparatus of claim 34, wherein said inference is based on the predetermined conditions.

36. The apparatus of claim 20, wherein said feedback control is one of a closed-loop and a quasi-closed-loop feedback control.

37. The apparatus of claim 20, further comprising means for determining a polarization of the one or more reflections, wherein the location and one or more characteristics for each of the one or more subsurface targets are determined based upon the determined polarization.

38. The apparatus of claim 20, wherein said treating includes one of heating and modifying the one or more subsurface targets.

✓ 39. A method of non-invasively identifying one or more subsurface targets for laser treatment at a tissue surface area, comprising the steps of:

directing a plurality of polarized lights having respective predetermined wavelengths at the tissue surface area;

detecting one or more reflections of each of said plurality of polarized lights;
locating one or more untreated target subsurface tissue structures under said tissue surface area in accordance with at least one of respective intensities and polarizations of said detected reflections;

extracting one or more points of said one or more untreated target subsurface tissue structures on said tissue surface area from said detected reflections in accordance with a line detection algorithm; and

identifying said one or more subsurface targets by selecting from said one or more points.

✗ 40. A set of computer program instructions for using feedback control to non-invasively identify and locate one or more subsurface targets based on predetermined conditions for selective laser treatment at a tissue surface area, comprising:

an instruction for detecting one or more reflections of light from the tissue surface area using a multi-dimensional photo-sensor;

an instruction for determining a location and one or more characteristics for each of the one or more subsurface targets based upon the one or more reflections detected by said photo-sensor and said predetermined conditions, said predetermined conditions defined at least in part by one of predetermined image analysis and mathematical algorithms; and

an instruction for selectively treating the one or more subsurface targets using a laser of a predetermined wavelength and a predetermined power in accordance with the determined location and the one or more determined characteristics.

41. The set of computer program instructions of claim 40, further comprising an instruction for directing one of a polarized and an unpolarized light having a predetermined wavelength at the tissue surface area.

42. The set of computer program instructions of claim 40, wherein the one or more determined characteristics include at least one of a size, a shape, a color, a contrast, a brightness, a pattern, a structure, and a treatment status of tissue at the one or more subsurface targets.

43. The set of computer program instructions of claim 40, wherein the one or more determined characteristics include at least one of photometric, spectrometric, and topological properties of tissue at the one or more subsurface targets.

44. The set of computer program instructions of claim 40, wherein the determined location for said each subsurface target is determined by inference from a corresponding detected location.

45. The set of computer program instructions of claim 44, wherein said inference is based on the predetermined conditions.

Spec's ✓ 46. An apparatus for providing feedback control and for non-invasively identifying and locating one or more subsurface targets based on predetermined conditions for selective laser treatment at a tissue surface area, said apparatus comprising:

means for directing one of a polarized and an unpolarized light having a predetermined wavelength at the tissue surface area;

means for detecting one or more reflections of said light using a multi-dimensional photo-sensor;

means for outputting data on the one or more detected reflections;

means for receiving input data; and

means for selectively treating the one or more subsurface targets using a laser of a predetermined wavelength and a predetermined power in accordance with the received input data, wherein

the input data is generated in accordance with a location and one or more characteristics for each of the one or more subsurface targets determined based upon the

outputted data on the one or more reflections and said predetermined conditions, said predetermined conditions defined at least in part by one of predetermined image analysis and mathematical algorithms.

47. The apparatus of claim 46, further comprising means for determining a polarization of the one or more reflections, wherein the location and one or more characteristics for each of the one or more subsurface targets are determined based upon the determined polarization.

48. A method of using a feedback control to non-invasively identify and locate one or more targets based on predetermined conditions for selective laser treatment, comprising the steps of:

directing one of a polarized and an unpolarized light having a predetermined wavelength at a tissue surface area;

detecting one or more reflections of said light using a multi-dimensional photo-sensor;

determining a location and one or more characteristics for each of the one or more targets based upon the one or more reflections detected by said photo-sensor and said predetermined conditions, said predetermined conditions defined at least in part by one of predetermined image analysis and mathematical algorithms; and

selectively treating the one or more targets using a laser of a predetermined wavelength and a predetermined power in accordance with the determined location and the one or more determined characteristics.

49. An apparatus, having a feedback control, for non-invasively identifying and locating one or more targets based on predetermined conditions for selective laser treatment, said apparatus comprising:

means for directing one of a polarized and an unpolarized light having a predetermined wavelength at a tissue surface area;

means for detecting one or more reflections of said light using a multi-dimensional photo-sensor;

means for determining a location and one or more characteristics for each of the one or more targets based upon the one or more reflections detected by said photo-sensor and said predetermined conditions, said predetermined conditions defined at least in part by one of predetermined image analysis and mathematical algorithms; and

means for selectively treating the one or more subsurface targets using a laser of a predetermined wavelength and a predetermined power in accordance with the determined location and the one or more determined characteristics.

50. An apparatus, having feedback control, for non-invasively identifying and locating one or more subsurface targets based on predetermined conditions for selective laser treatment at a tissue surface area, said apparatus comprising:

an illumination device adapted to direct one of a polarized and an unpolarized light having a predetermined wavelength at the tissue surface area;

a light detection device adapted to detect one or more reflections of said light using a multi-dimensional photo-sensor;

a computing device coupled to said illumination device and said light detection device, said computing device adapted to determine a location and one or more characteristics for each of the one or more subsurface targets based upon the one or more reflections detected by said photo-sensor and said predetermined conditions, said predetermined conditions defined at least in part by one of predetermined image analysis and mathematical algorithms; and

a laser device coupled to the computing device, said laser device adapted to selectively treat the one or more subsurface targets using a laser of a predetermined wavelength and a predetermined power in accordance with the determined location and the one or more determined characteristics.

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